Section 3: Fish and Wildlife Contaminants

3.1 Contaminants in Fish

The Michigan Department of Environmental Quality and the Ontario Ministry of the Environment collect and analyze many species of fish to determine whether chemicals are present in quantities that may be of concern to those eating sport-caught fish. Contaminants such as mercury, toxaphene, dioxins, and polychlorinated biphenyls (PCBs) can accumulate in fish, wildlife and humans and could be harmful to a developing fetus, young child or breast-feeding baby.

The sport fish contaminant monitoring program is the largest testing and advisory program of its kind in North America. Both Michigan and Ontario have major fish contaminant analysis programs in place which include coverage of the Lake Huron watershed. These programs annually evaluate the available fish contaminant information and place advisories on the consumption of specific species of fish depending on the levels of contaminants found.

3.1.1 Contaminant Trends

From the late 1970's to the early 1990's, concentrations of persistent, bioaccumulative substance such as PCB, DDT, dieldrin, dioxins, and furans declined significantly in Lake Huron lake trout. However, while concentrations of DDT continued to decline up until 1995, PCB concentrations have not declined significantly since the mid 1980s (Figure 3.1). As with other trends, concentrations decreased significantly in the late 1970s but have remained relatively stable since.

Lake Huron Contaminant Trends in Top Predator Fish

Contaminant	Long-term Trends	Recent Trends
PCBs	Declining	Leveling off
Dioxins	General decline	
Mercury	General decline	Leveling off
DDT	Declining	

Source: Environment Canada/U.S. Environmental Protection Agency, 1997

Figure 3.1

Continuing sources of contaminants are primarily from sediments contaminated by historic discharges, airborne deposition, industrial and municipal discharges and land runoff. Contaminants enter Lake Huron through a variety of pathways including direct discharges, atmospheric deposition, and tributary discharge. Pesticides such as DDT, Toxaphene, Mirex, Chlordane and Aldrin/Dieldrin have been banned from use in the U.S. and Canada; however, they are still cycling within the environment through run-off, sediment resuspension and long range atmospheric transport. The large surface area of Lake Huron, like the other Great Lakes, has made it particularly vulnerable to atmospheric deposition of contaminants. Lake Huron has a large surface area and relatively few local contaminant point sources. Pollutant loadings to Lake Huron from water sources are lowest of all the Great Lakes but air sources are highest. The persistence of contaminants in the aquatic environment varies from substance to substance.

The breakdown or transformation of contaminants into forms that are inactive or less toxic may take anywhere from minutes to years. As a result, for the more persistent substances such as PCBs and DDT,

it may take many years of collecting and assessing data for trends to become clear. The data collected through the sport fish contaminant monitoring programs are particularly effective in detecting increases or decreases in contaminant levels over time.

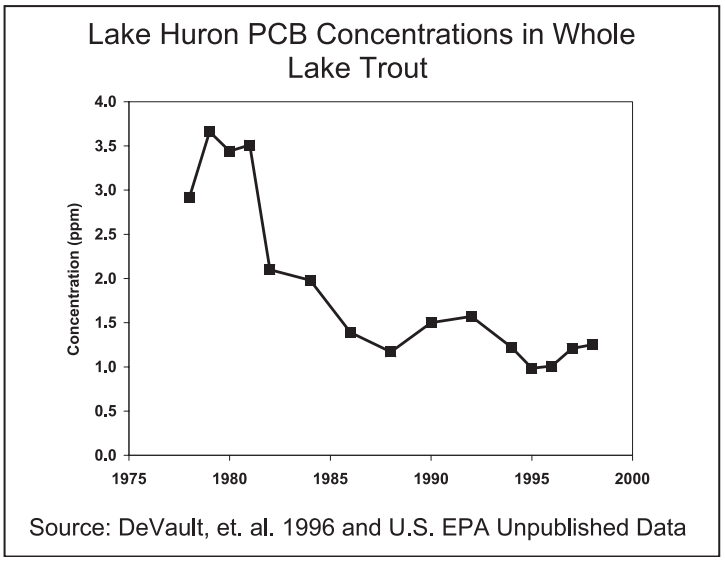


Figure 3.2

Contaminant concentrations in fish from the open waters of Lake Huron have been monitored because of human and wildlife health concerns. Because certain contaminants bioaccumulate and biomagnify in the food chain, fish are excellent indicators of pollutants in the aquatic ecosystem. Over the long term, trends of PCBs in fish have tended to closely follow those in the water column and have provided a measure of the relative rates at which chemicals have entered the Lake Huron ecosystem. During the period 1977-1990, PCB concentrations declined significantly in lake trout in Lake Huron (Figure 3.2). However, these declines have not continued in recent years. Compared to the rate at which PCBs declined in lake trout over earlier time periods, concentrations have not declined significantly in lake trout from Lake Huron since the mid 1980s. While PCB concentrations in open lake fish have declined dramatically in response to regulatory activity, concentrations in top predator fish species are still above the Great Lakes Water Quality Agreement objective of 0.1 ug/g (in whole fish).

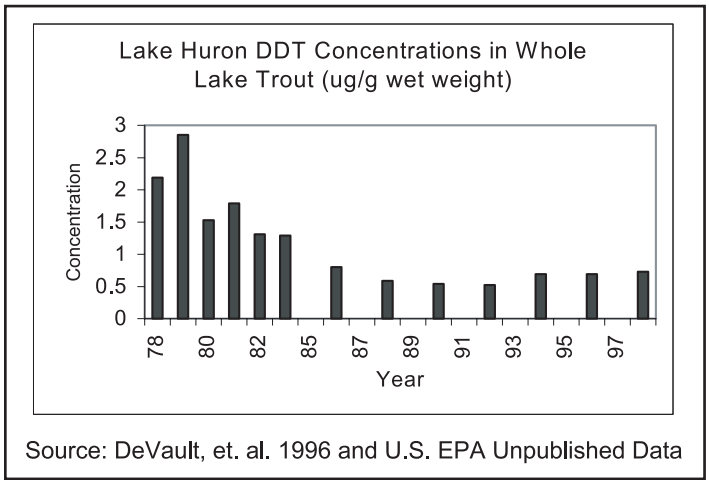


Figure 3.3

Total DDT declined significantly over the period of record in fish from Lake Huron (Figure 3.3). DDT concentrations have increased slightly in Lake Huron since 1995. Average DDT concentrations are below the International Joint Commission's Great Lakes Water Quality Agreement objective of 1.0 ug/g in whole fish.

In most areas of Ontario, contaminant levels have been declining due to bans on harmful substances and restrictions on emissions. Ontario sportfish contaminants analyses are based on the dorsal fillet section of the fish, not the whole fish as in Michigan. In the Ontario waters of Lake Huron, PCB levels in sport fish have been steadily declining to below the consumption restriction guideline (500 ppb). However, from 1990 to 2002, levels have remained stable. In Figure 3.4, the lake-wide average PCB levels for five year intervals in a typical (55cm) lake trout are shown. Figure 3.5 shows the lake-wide average dioxin/furan toxic equivalents in lake trout. Dioxin and furan levels exceeded the consumption guideline for 55 cm lake trout in 1990. Since that time levels have also declined considerably.

In Figure 3.6, the mean lake-wide mercury levels are compared in multiple year categories. The mercury concentrations in walleye have declined and remain below the consumption restriction guideline (0.45 ppm). However, mercury levels have been relatively stable over the past 20 years. Toxaphene, a banned persistent insecticide, exceeded the consumption restriction guideline (201 ppb) between 1987 and 1995 for 55 cm lake trout. Since that time, toxaphene levels have declined to below consumption guidelines.

In Georgian Bay, PCB levels are generally lower than in Lake Huron. Figure 3.7 shows PCB concentrations in 55 cm lake trout. None of the levels exceeded the guideline for fish consumption (500 ppb). Toxaphene concentrations in 55 cm lake trout from Georgian Bay exceeded the consumption guideline (201 ppb)

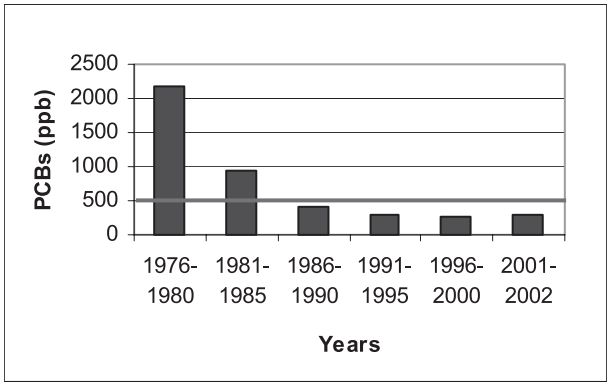


Figure 3.4 PCB concentrations in 55 cm lake trout from Lake Huron (Source: OMOE, 2004).

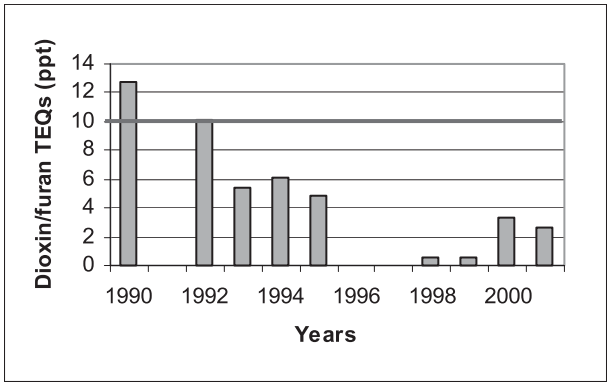


Figure 3.5 Dioxin/furan levels in 55 cm lake trout from Lake Huron (Source: OMOE, 2004).

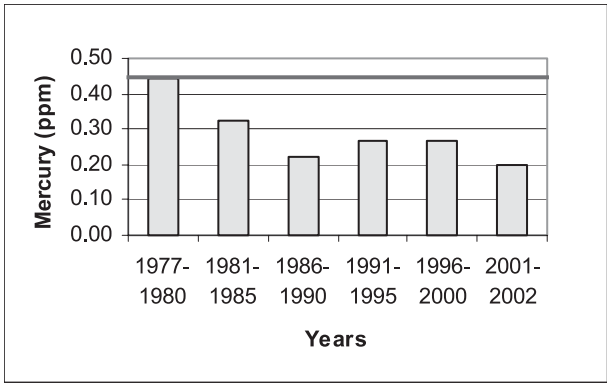


Figure 3.6 Mercury concentrations in 45 cm walleye from Lake Huron (Source: OMOE, 2004).

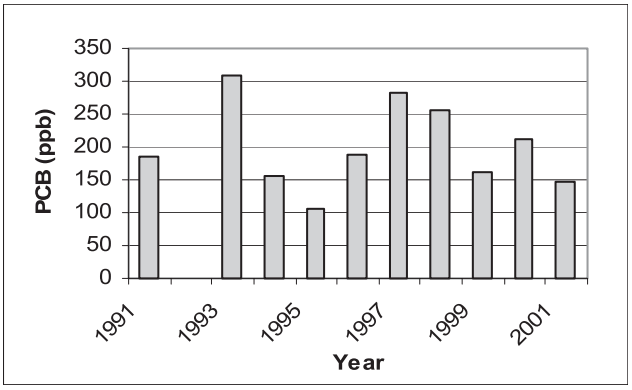


Figure 3.7 PCB concentrations in 55 cm lake trout from Georgian Bay (Source: OMOE, 2004).

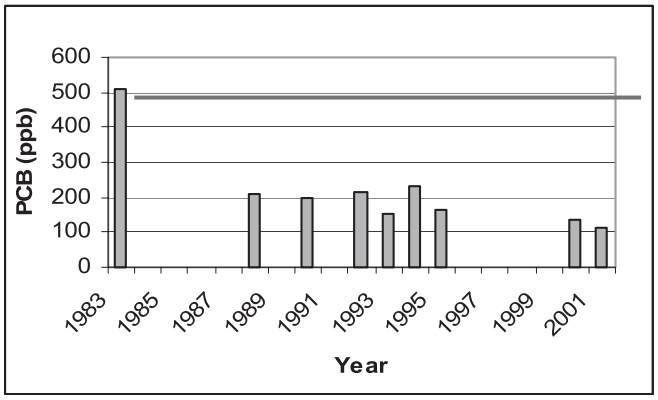


Figure 3.8 PCB concentrations in 55 cm lake trout from the North Channel (Source: OMOE, 2004).

between 1996 and 1997. Since that time, toxaphene levels have decreased to below the consumption restriction guidelines in Georgian Bay. In the 2003-04 guide, dioxins and furans were the cause of only one consumption restriction (65-75 cm lake trout). Overall, the percentage of consumption restrictions for fish from Georgian Bay (15.5%) was much less than those for Lake Huron (26%).

In the North Channel, the percentage of fish consumption restrictions (16.5%) is also much lower than in Lake Huron. The PCB levels in lake trout in the North Channel have declined since 1983 (Figure 3.8). Recent levels are well below the consumption restriction guideline (500 ppb). Toxaphene levels in 55cm lake trout exceeded the consumption guideline in 1987 and 1989 but have decreased considerably since that time.

3.1.2 Fish Consumption Advisories

Fish consumption advisories are based on guidelines developed through research and review of toxicological data. Both Michigan and Ontario have determined a safe dose for an extensive list of contaminants. This amount is referred to as a tolerable daily intake. It is then determined what proportion of the tolerable daily intake comes from each of the environmental pathways (e.g. air, water, different types of food), including sport fish consumption. A series of estimates and calculations are then done to determine if fish are

suitable for consumption. Fish Consumption Advisories are meant to inform consumers of the potential concerns.

In comparison to the other Great Lakes, contaminant concentrations are relatively low in Lake Huron. Nevertheless, fish consumption advisories exist for the open lake and all Areas of Concern (St. Marys River, Saginaw Bay and the Spanish River). Advisories differ by species, size and location, so it is important to check advisories in effect for the appropriate area.

In the Ontario waters of Lake Huron (including Georgian Bay, North Channel and St. Marys River) generally, the restrictions on trout, salmon, carp and channel catfish are caused by PCBs (Figure 3.9). The restrictions on other species are usually caused by mercury. In total, over 20 percent of the advice given for sport fish from Lake Huron results in some level of consumption restriction.

In the Michigan waters of Lake Huron (including Saginaw Bay and the St. Marys River) generally, the restrictions on trout, salmon, carp, channel catfish, burbot, northern pike, walleye, white bass, white suckers,

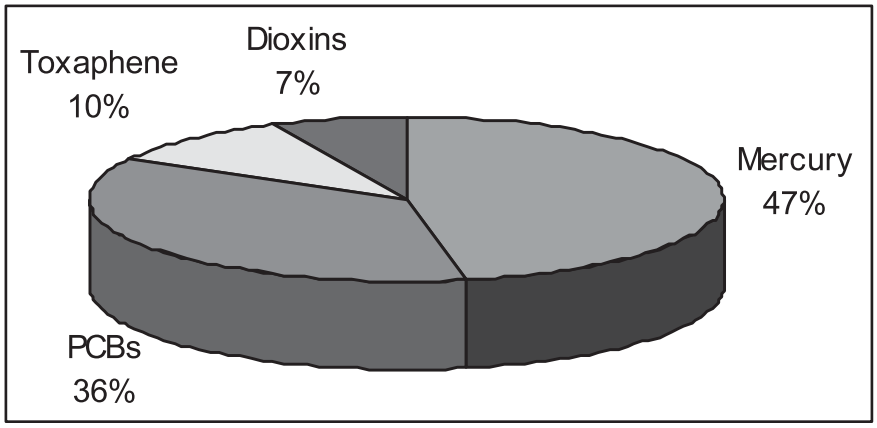


Figure 3.9 Causes of fish consumption advisories for the Lake Huron Watershed (2003-04 Guide to Eating Ontario Sport Fish (MOE)).

white perch and yellow perch are caused by PCBs. The other restrictions are caused by chlordane, dioxins, or mercury.

Based on the most recent information the current status of sport fish consumption advisories for both Ontario and Michigan are as shown below:

PCBs – In Michigan waters, almost every sample collected from Lake Huron exceeded the trigger level used by the Michigan Department of Community Health to issue sport fish consumption advisories for the protection of women of child bearing age and children under 15 years of age. Sport fish consumption advisories cover 15 species of Lake Huron fish. In addition, fish from several Lake Huron tributaries are covered by sport fish consumption advisories due to elevated concentrations of PCBs.

Toxaphene - Several species of Lake Huron fish including lake trout, lake whitefish and brown trout had toxaphene concentrations above the Ontario Ministry of Environment's sport fish consumption advisory trigger level.

Dioxins - Fewer dioxin analyses have been conducted on Lake Huron fish because of the relatively high cost of analyses. However, lake trout, lake whitefish and carp have dioxin concentrations above the trigger level used by both the Michigan Department of Community Health and the Ontario Ministry of Environment to issue sport fish consumption advisories. In addition, fish from the Saginaw River watershed are covered by advisories due to elevated concentrations of dioxin.

Chlordane - Concentrations of chlordane in Lake Huron lake trout occasionally exceed the sport fish consumption advisory trigger level (Figure 3.10).

Mercury - Only the methylated form of mercury bioaccumulates in fish tissue and a number of characteristics influence the methylation of mercury in the aquatic environment. Mercury methylation occurs more readily in inland lakes than in the Great Lakes. Therefore, sportfish consumption advisories due to elevated levels of mercury are more prevalent in fish from inland lakes within the Lake Huron watershed rather than fish from Lake Huron.

DDT/PBB - Concentrations of DDT and PBB rarely exceed sportfish consumption advisory trigger levels in Lake Huron fish. The only area of the Lake Huron watershed where concentrations are elevated is in the Pine River in the Saginaw River watershed.

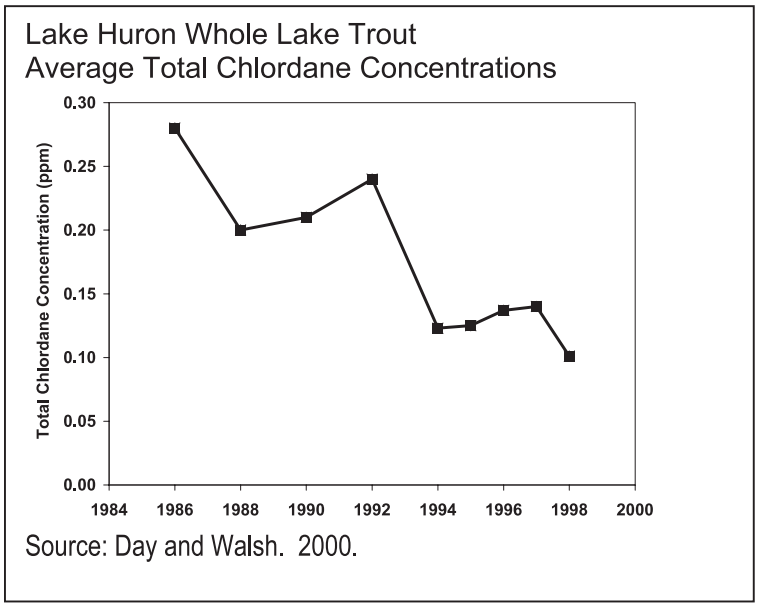


Figure 3.10

3.2 Contaminants in Wildlife

In the early 1970s, fish-eating birds (eagles, gulls, cormorants, etc.) on Lake Huron suffered widespread contaminant-induced reproductive failure, declining populations and eggshell thinning. With reductions in loadings of persistent toxic contaminants, such as PCBs, most fish-eating bird populations have recovered; numbers of herring gulls, Caspian terns, black-crowned night-herons and double-crested cormorants have increased significantly. However, some contaminant-associated problems, e.g. birth defects, impaired physiological responses and/ or reproductive failure, continue to occur in a small percentage of the populations in local areas.

It is important to monitor temporal and spatial trends in contaminants in these species and to identify potential problem areas and sources. Recently, to obtain more detailed geographical information, monitoring programs have included other aquatic-feeding species such as reptiles, amphibians, mink and otter. Contaminants such as PCBs, chlordane, dioxins and DDT have a strong association with reproduction and health in these species and this information, together with the fish-eating bird monitoring data, provides a more complete picture of the wildlife health effects of contaminants in the Lake Huron ecosystem.

3.2.1 Fish-Eating Birds

The Canadian Wildlife Service (CWS) of Environment Canada has been monitoring contaminant levels in herring gull eggs at 15 Great Lakes sites since 1974. The three Lake Huron sites are: Channel-Shelter Island, Double Island and Chantry Island (Figure 3.11).

The program tracks temporal and spatial trends in contaminant levels and effects in a top avian aquatic predator in the Great Lakes food web. Contaminants levels have declined dramatically at all three CWS Lake Huron sites since 1974, although the rates of decline for some compounds slowed during the 1990s (Figure 3.12). In spite of these declines, PCB and dioxin levels in gull eggs from Channel-Shelter Island continued to remain elevated compared to other Great Lakes sites. While major point sources

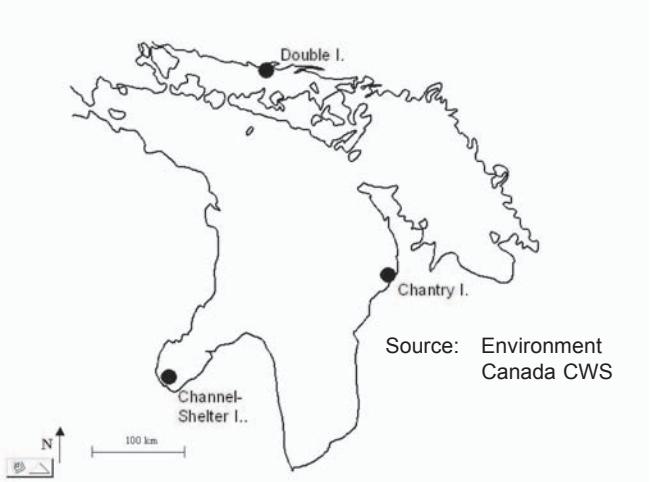


Figure 3.11 Canadian Wildlife Service Annual Herring Gull Monitoring Sites

of chemical contaminants are not found on the Canadian side of Lake Huron, atmospheric deposition, agricultural run-off, re-suspension of sediments and leaching of soils from landfill sites contribute to the steady state that has been evident since the 1990s. Year-to-year fluctuations in contaminant levels result from changes in food abundance associated with/or changes in weather conditions (Fox et al. 1990, Ewins et al. 1992).

The Michigan Department of Environmental Quality (MDEQ) began a similar annual gull egg monitoring project in 1999, augmenting the CWS work. Their sites include the outer Saginaw Bay, Alpena, St. Ignace and Sault Ste. Marie. MDEQ data are reviewed each year for new parameters for which wildlife should be analyzed.

High concentrations of brominated diphenyl ethers (BDEs) in Great Lakes herring gulls have recently been identified as a concern (Norstrom et al. 2003). Total BDE in herring gull eggs sampled from Double and Chantry Islands in 2000 were low (308-320 ug/kg) in comparison to other Great Lakes sites (1400 ug/kg in Green Bay), largely due to their remoteness from large urban/heavy industrial centres. Little is known with regard to the toxic effects of brominated diphenyl ethers in humans and wildlife.

In addition to Herring gull egg monitoring, the CWS occasionally measures contaminants in eggs from double-crested cormorants, ring-billed gulls, black-crowned night herons, great black-backed gulls and several species of terns. Generally, levels of contaminants in these species from Lake Huron sites were lower than other Great Lakes sites (Pekarik et al 1998; CWS unpublished).

In hunted waterfowl from Georgian Bay and Sault Ste. Marie, Braun et al. (1999) found that organochlorines, PCBs and mercury in pectoral muscle were low and did not pose a risk to wildlife. One exception was a common merganser from Sault Ste. Marie with the highest PCB concentrations of all waterfowl and gamebirds collected across Canada from 1987 to 1995. The reason for these high levels is unknown.

Bald eagles are a very sensitive top level predator and are often considered the ultimate contaminant indicator species. They have begun to return to the Great Lakes and can be used as indicators of contaminant trends by sampling contaminants in blood. Elevated levels of contaminants have been found in some eaglet blood samples from Georgian Bay (Donaldson et al. 1999) and Lake Huron watersheds (Saginaw River, Shiawassee Cutoff) although the 1999-2001 samples were significantly lower than in 1987-1992 (Roe et al. 2004)

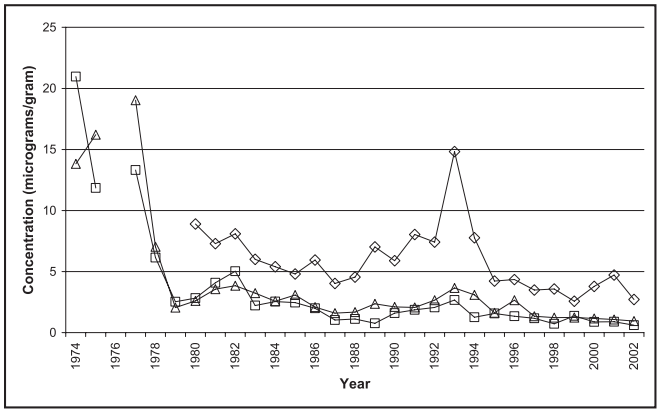
Exposure to heavy metals has been identified as a concern for bald eagles since several bald eagles found dead in the last few years in Ontario have had elevated levels of both mercury and lead in their bodies (Badzinski and Richards, 2002). Adult longevity and nest occupancy turn-over rates, including age of replacement birds, are other important factors which will ultimately determine how successful nesting bald eagles are on the shores of Lake Huron.

Ospreys are often used as local indicators in areas where there are few or no eagles. During 1991-1993 DDE concentrations in Osprey eggs and plasma were significantly higher in Georgian Bay than at inland sites in Ontario (Martin et al. 2003). Mean concentrations of DDE were lower than the critical value (4.2 ug/g) associated with significant eggshell thinning, however 20% of eggs from Georgian Bay were above this level. In terms of heavy metals, all samples taken from the St. Marys River and Georgian Bay (1991-1993) had mercury levels below those expected to cause adverse effects on reproduction. Thus, the Canadian Lake Huron osprey population does not appear to be affected by the current level of contaminants.

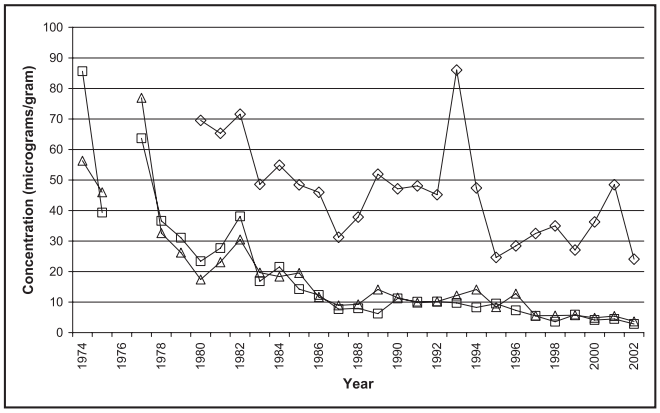
3.2.2 Other Wildlife

Snapping turtles are ideal monitors of wetland health due to their sedentary nature, their position as a top predator in the food chain and their ability to accumulate high levels of contaminants over the course of their long lives. Geographic variation in contaminant levels have been shown to be similar to the variation reported for herring gull eggs at other Great Lakes sites (Struger et al. 1985). Mink and otter both live in wetland habitat near the shoreline and consume various amounts of fish in their diet. Mink are one of the most sensitive mammals to PCBs, resulting in reproductive problems and death. Trends in mink populations have followed those of fish-eating birds; the population began to decline in the mid 1950s and was lowest

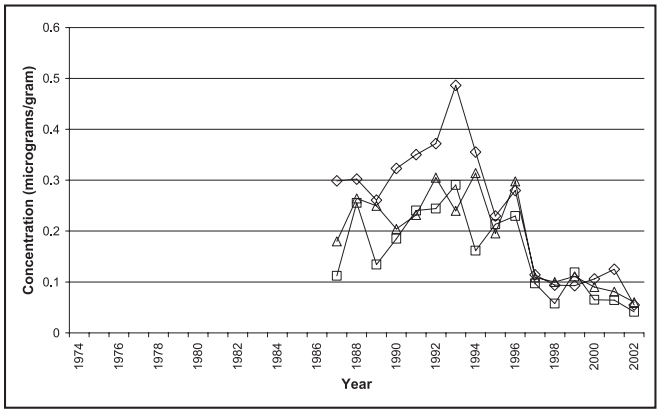
Figure 3.12 Temporal Trends in Levels of Contaminants in Herring Gull Eggs at Three Lake Huron Annual Monitor Colonies.



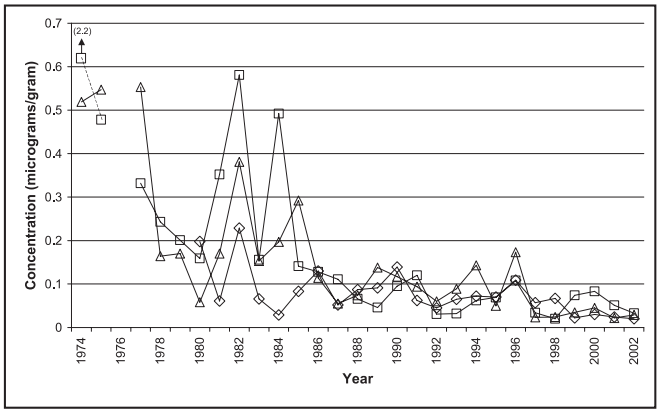
a) DDE



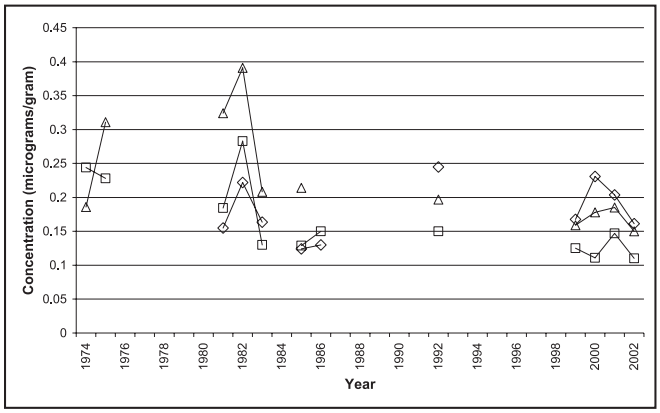
b) PCB 1254:1260



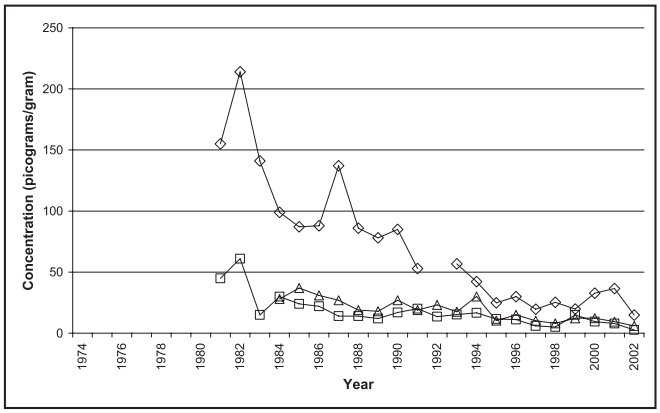
c) Total chlordane



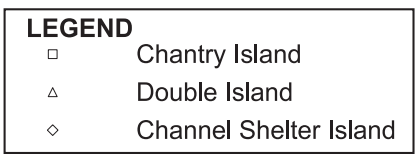
d) Mirex



e) Mercury



f) 2,3,7,8-tetrachlorodibenzo-p-dioxin



in the early 1970s but recovered somewhat in the 1980s. Otter have a lower rate of reproduction and therefore, are slower to recover.

Mink and otter are also sensitive indicators of mercury in the aquatic environment. Total mercury concentrations in otter tissues from near Parry Sound were higher than those in mink tissues, possibly due to their more piscivorous-based diet compared to mink (Klenavic, 2004). Mercury levels in otter hair were within the range found in studies in southern Ontario. Levels reported for Lake Huron otter were well below action thresholds.

In summary, wildlife information has indicated that PCBs, chlordane, dioxins and DDT are a concern in the Lake Huron basin although, with the exception of Saginaw Bay (PCBs, dioxin), concentrations are low compared to the other Great Lakes. Concentrations have declined significantly since the early 1970s but still remain at levels associated with deformities and reproductive effects in several local watersheds in Michigan, especially Saginaw Bay. Data collected in Ontario's wildlife species were generally not at levels of concern although sporadic elevated measurements support the need for continued ongoing monitoring.

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